APPENDIX E
SPECIAL CONSIDERATIONS FOR COLD CLIMATES

E-1. General considerations.

Arctic and subarctic conditions which exist at either pole present unique problems for design, construction and maintenance of wastewater treatment systems. Fortunately, military engineers have gained valuable experience in Alaska, Greenland, Canada, Antarctica and Iceland during and following World War II. Further; there exists a body of Scandanavian, Canadian and Russian literature on the special challenges of these harsh climates. For a view of Canadian and Scandanavian engineering, utilize the University of Alberta seminar report (Smith, DW, and Hrudey, SE., **Design of Water and Wastewater Services for Cold Climate Communities,** Pergamon Press, Toronto). These technical reports address the problems of extreme cold, wind and snow, high cost, remote location, thermal stress on structures, frost heaving, permafrost, and the limited availability of construction materials, skilled labor and time for construction and/or maintenance. Extreme low temperature is common: as low as -75 degrees Fahrenheit in interior locations in northern Canada; below -100 degrees Fahrenheit in Antarctica; and a month or more of sub-zero air temperature in the Arctic. Water; sewer; electric utilities and steam lines are all run in utilidors above ground to conserve their heat, allow easy access and conserve materials, Utilidors are kept insulated from the ground because the permafrost can be alternately melted and frozen if trenches are used. TM 5-852-1/AFR 88-19, Volume 1, should be consulted when considering the problems of building on permafrost or seasonal frost soils.

E-2. Wind protection.

Wind in the arctic zone produces a great heat loss problem which is reflected in wind chill factors (TM 5-852-1/AFM 88-19, Chapter 1). Precipitation in northern climates is actually quite low, but the snow produces drifts and can cause severe problems in transportation and operation should the engineer fail to consider wind. Obviously, snow and wind load on structures requires careful consideration. Rotating biological equipment and other covered equipment must not only be well insulated, but must be designed to withstand thermal extremes, buffeting wind loads and wet spring snow.

E-3. Conservation practices.

In general, military bases, unlike some arctic civilian communities, practice water conservation. The wastewater from these bases is high strength since water consumption is normally low, infiltration is nil and stormwater is excluded. Since wastewater is transported above the ground surface or in well-insulated, well-constructed tunnels, fresh water use is almost the same as wastewater return. Design conditions should be expected to be about 300 milligrams per liter at 60 to 80 gallons per capita per day. Wastewater will be delivered to the plant at around 50 degrees Fahrenheit.

E-4. Modifications for viscosity and dissolved oxygen variations.

All processes where operation is viscosity dependent must be corrected for increased viscosity. This would include sedimentation tanks, filters and oxidation ponds. All processes which involve oxygen transfer will be aided by the increased solubility of oxygen at low temperatures; but to overcome the deleterious effect of increased viscosity, more mixing will be required. An absorption process such as oxygen bubble-water transfer is enhanced by the lower temperature but the lower viscosity reduces the rate of contact so that, overall, neither oxygen transfer nor absorption change in rate. All chemical reactions, especially those involving partially soluble salts, must be recalculated to reflect the low solubility of chemicals in cold water. Each flocculent or deflocculent, each polymer and each detergent or other organic chemical used must be tested for unanticipated interaction brought about by low temperatures.

E-5. Insulation of appurtenances.

Trash racks, bar screens, grit chambers, unit-process tanks, biological reactors, aerators, gates, walkways and instrumental sensing devices must be heated or insulated or redesigned to withstand icing and snow pack. Additional information may be found in TM 5-852-1/AFR 88-19, Volume 1; TM 5-852-4/AFM 88-19, Chapter 4; and TM 5-852-5.